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DYNAMIC MAP AND DIFFSERV BASED AR SELECTION FOR HANDOFF IN HMIPV6 NETWORKS

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Abstract: *In HMIPv6 Networks, most of the existing handoff decision mechanisms deal mainly with the selection of Mobility Anchor Point (MAP), ignoring the selection of access router (AR) under each MAP. In this paper, we propose a new mechanism called "Dynamic MAP and Diffserv based ARs selection for Handoff in HMIPv6 networks" and it deals with selecting the MAP as well as ARs. MAP will be selected dynamically by checking load, session mobility ratio (SMR), Binding update cost and Location Rate. After selecting the best MAP, the Diffserv approach is used to select the AR under the MAP, based on its resource availability. The AR is implemented at the edge router of Diffserv. DiffServ can be used to provide low-latency to critical network traffic such as voice or streaming media while providing simple best-effort service to non-critical services such as web traffic or file transfers. By using this mechanism, we can assure that better resource utilization and throughput can be attained during Handoff in HMIPv6 networks.*

Keywords: *HMIPV6 Networks, Access Router (AR), Session Mobility Ratio (SMR).*

I. INTRODUCTION

To mitigate the high signaling overhead occurring in Mobile IPv6 networks when mobile nodes (MNs) perform frequent handoffs, a Hierarchical Mobile IPv6 (HMIPv6) was proposed by Internet Engineering Task Force (IETF) [1] [2]. The Mobility Anchor Point (MAP) was introduced in HMIPV6 to reduce the considerable number of the binding update (BU) messages between the mobile node (MN), the correspondent node (CN), and the home agent (HA). MAP is to handle the binding update (BU) procedures due to handoffs within a MAP domain in a localized manner, which reduces the amount of network- wide signaling traffic for mobility.

Hierarchical Mobile IPv6 (HMIPv6) is an extension of MIPv6 and it has been proposed to reduce the signaling load and to improve the handover speed for mobile connections. It reduces the signaling load outside the MAP domain in case of handoffs within the same domain and may improve handoff performance reducing handoff latency and thus packet losses since intra domain handcuffs are performed locally. This is the main advantage of HMIPV6.

The MAP basically acts as a local Home Agent (HA) and, as such, it receives all packets on behalf of the MNs it is serving. That is the MAP decapsulates and forwards the received packets to the MN's current address. In HMIPv6 networks, an MN configures two cars: a regional care-of-address (RCoA) and an on-line care-of-address (LCoA). The RCoA is an address in the MAP's subnet. When a mobile node enters into a new MAP domain, it registers with itself by obtaining a Regional Care-of-Address (RCoA) [3] [4]. The RCoA is the address that the mobile node will use to inform its Home Agent and corresponding nodes about its current location. Then, the packets would be sent to and intercepted by the MAP, acting as a proxy, and routed inside the domain to the on-link care-of-address (LCoA) by the MAP. On the other hand, the LCoA is an on-link CoA attributed to the MN's interface and it is based on the prefix information advertised by an AR. After configuring the LCoA and RCoA, the MN sends a BU message to the MAP, which then maintains the binding information between the RCoA and the LCoA (i.e., Local binding update).

When the MN changes its current address within a MAP domain, then it needs to register the new address (i.e., New LCoA) with the MAP. When it moves to another MAP domain then only its RCoA will change and it does not change as long as the MN moves within the same MAP domain. This makes the MN's mobility transparent for the correspondent nodes (CNs). After configuring the LCoA and RCoA, the MN sends a BU message to the MAP, which then maintains the binding information between the RCoA and the LCoA. Also, the MN sends a BU message containing the MN's home address (HoA) and the RCoA to it's HA and CNs. The MN's RCoA is not changed while the MN resides in the MAP domain and therefore the MN

need to send a local BU message only to the MAP (not to its HA) for a movement within the MAP domain. As a result, HMIPv6 only reduces times needed to binding update in the handover procedures.

In HMIPv6 networks, one or more MAPs can be located within the same network hierarchy and a MAP can exist at any level in the pecking order, including at the level of the AR, operate independently of one another. Especially, when HMIPv6 is deployed in large-scale wireless/ mobile networks, multiple MAPs are deployed to provide scalable mobile services. It is very important for an MN to select the most suitable MAP among the available MAPs, in order to reduce the total cost. Here, the total cost, incurred by an MN in a HMIPv6 network, consists of the binding update cost and the packet deliver cost.

An MN needs to consider several factors when selecting the optimal MAP that minimizes the total cost among the various MAPs available in a foreign network. The advantage of having an appropriate MAP selection that covers most of the MN's mobility area is, we can significantly reduce the binding updates (global binding update and local binding update) to the HA and further reduce the signaling cost and location update cost in HMIP. The global binding update is a procedure in which MN registers its RCoA with the CNs and HA. On the other hand, a local binding update occurs when MN changes its current address within a local MAP domain, it only needs to register the new address with the MAP. If a mobile node then performs a handoff between two access points within the same MAP domain only the MAP has to be informed. Note, this does not imply any change to the periodic BUs, a MN has to send to the HA, CNs and now additionally to the MAP.

Hierarchical mobile IPv6 (HMIPv6) protocol is proposed by employing a hierarchical network structure to reduce handoff latency. HMIPv6 protocol suffers the long handoff delay and the high packet lost in the macro mobility. [1][2][6]

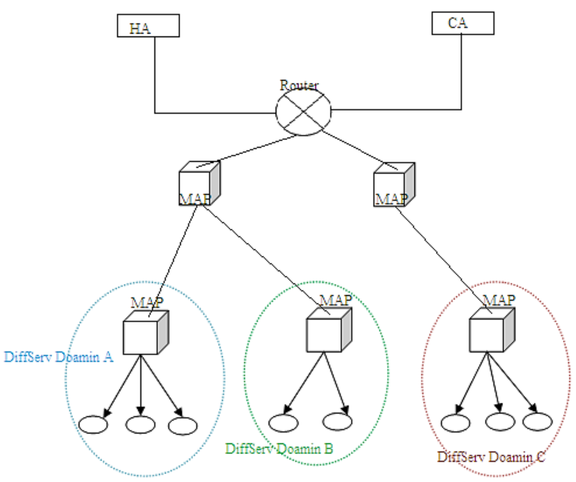

Figure 1: System Architecture

BS: Base Station
CN: Corresponding Node
HA: Home Agent
MS: Mobile Station
MAP: Mobility Anchor Point
AR: Access Router

Figure 1 illustrates the basic operations that are performed in HMIPv6 networks. The HMIPv6 is composed of a HA, a CN, Five MAPs, Seven ARs and a MN. There are three Diffserv domains: domain A, domain B and domain C. Each domain has its own unique Diffserv domain number which is used to inform the MN which Diffserv domain the MN belongs to. If the MN has received the information and found that the Diffserv domain number was changed from the present, it means that the MN has moved to the boundary of new Diffserv domain and is required to configure the Diffserv configuration parameters within itself in order to use the new Diffserv domain.

In this paper we propose a new mechanism called "Dynamic MAP and Diffserv based ARs selection for Handoff in HMIPv6 networks" that deals with selecting the MAP as well as ARs. In Dynamic MAP selection we are considering the load, Session Mobility Ration, Binding update cost and Location Rate, based on these two we will select an optimal MAP. After selecting the best MAP, the Diffserv approach is used to select the AR under the MAP, based on its resource availability. The AR is implemented as the edge router of Diffserv. By using this mechanism, we can assure that better resource utilization and throughput can be attained during Handoff in HMIPv6 networks.

II. RELATED WORK

Dong-Guen Kim et al, in [6] have proposed a network-based handover approach for HMIPv6 networks. If handover in HMIPv6 occurs while handover process in IEEE 802.16e is in progress, then the total handover latency will be significantly reduced. This scheme uses the network-based handover approach in which access routers (AR) generate local binding update on behalf of MN. This allows L3 handover and L2 handover to happen at the same time. This scheme also minimizes packet losses. By introducing additional management messages, AR can buffer the packets destined to MN until total handover process is finished. This technique does not deal with the handover performance of macro mobility in HMIPv6 networks.

Sangheon Pack et al., in [7] have proposed an adaptive MAP selection scheme for HMIPv6 networks. In the adaptive MAP selection scheme, an MN first estimates its session-to-mobility ratio (SMR). Then, based on its SMR, the MN chooses a MAP that minimizes the total cost, consisting of the binding

update cost and packet delivery cost. In addition, the MN calculates two threshold SMR values, which adaptively trigger a new MAP selection procedure. If the estimated SMR is larger (or smaller) than the upper (or lower) threshold SMR value, the MN recalculates the total cost and re-selects a MAP that minimizes the total cost. The adaptive MAP selection scheme results in a degree of computation overhead at the side of MNs, since MNs should monitor the session arrival and mobility rates.

Ying Hong Wang et al., in [8] have proposed a dynamic MAP selection mechanism for the Hierarchical Mobile IPv6 networks. According to the HMIPv6 mechanism, the MAP of higher layer can efficiently reduce the frequency of performing binding update; the higher loading of service is the bottleneck of the whole network. Because the bandwidth of the MAP which can serve is finite, the whole network will be crashed due to the overloading if the MAP serves as the gateway at the same time. So the authors have proposed a MAP selection mechanism that takes the mobile node's particular characteristics which include the mobility velocity and quantity of communication services into consideration, the proposal can manage the MAPs efficiently. They also have designed a MAP load balancing mechanism to avoid the network crash due to the overloaded MAP. This technique does not predict the movement direction of the MN.

WonSik Chung et al., in [9] have introduced a two novel dynamic MAP selection schemes(LV-MAP and DV-MAP) for HMIPv6, that relieve overloaded MAPs as well as select a more suitable MAP according to each Mobile Node (MN)'s up-to date mobility towards reducing inter-domain handover, resulting in saving the overall signaling cost. LV-MAP scheme distributes load over multiple MAPs for an overloaded HMIPv6 network while DVMAP selects the furthest MAP supporting MN's velocity for less overloaded situation, with the aim to reduce the frequency of inter-domain handovers and distribute load over the MAPs

Yuh-Shyan Chen et al., in [10] presents a new cross-layer partner-assisted handoff mechanism based on HMIPv6, termed as P_HMIPv6 protocol. The P_HMIPv6 protocol is a cross-layer approach by the combination of layer 2 and layer 3. The partner station (PS) is a new component with relay ability and adopted by our protocol. With the assistance of the PS, care-of address (CoA) is pre-acquired and DAD operation is pre-executed by the PS before the MS initiates the layer 2 handoff. The simulation results show that P_HMIPv6 protocol actually achieves the performance improvements in handoff delay time, packet loss rate, and handoff delay jitter. This technique does not consider the security issue of cross-layer partner-based handoff scheme for WiMax networks.

From the Previous works, we can say that the handoff decision mechanisms for HMIPv6 deal mainly with selection of MAP, ignoring the selection of access routers (AR) under each MAP. Our mechanism "Dynamic MAP and Diffserv based ARs selection for Handoff in HMIPv6 networks" deals with selecting the MAP as well as ARs. MAP will be selected dynamically by checking load and session mobility ratio (SMR) [6]. After selecting the best MAP, the Diffserv approach is used to select the AR under the MAP, based on its resource availability. The AR is implemented as the edge router of Diffserv.

III. DYNAMIC MAP AND DIFFSERV BASED AR SELECTION

A. Overview of the Proposed Work

Traffic Control and management are essential for every mobile application due to the limited resources of the mobile network. The main goal of our work is to enable the *MN* to choose the best *MAP* and the *MAP* will choose the best *AR* before performing handover and to provide quality of service for each application type of *MN*.

We propose a dynamic *MAP* selection mechanism based on the checking load, session mobility ratio *(SMR)*, Binding update cost and Location Rate of *MN* that reduces the handoff latency and hence improving location update and packet delivery. The main goals of our framework are to enable *MN* to be able to choose the best *AR* before performing the handover and quality of service of each application type on *MN*. An *MN* determines its serving *MAP* based on the estimated session –to-mobility. By considering the SMR in the selection of *MAP*, the *MN* is able to select a more appropriate *MAP* with respect to its own mobility and session activity.

After selecting the best *MAP*, we are using the Differentiated Services (Diffserv) approach to select the *AR* under the MAP, based on its resource availability. The *AR* is implemented at the edge router of Diffserv. We are adding two more parameters to the Diffserv to select the optimal *AR* and those two parameters are Signal Strength and Moving direction. When the *MN* disconnect from old Access Router (*oAR*), all packets will buffer at new Access router. After the *MN* connects to the new Access Router (*nAR*), the *nAR* then forwards any buffered packets to the MN. By using the Diffserv we will provide QoS guarantees for mobile host in *nAR* before mobile host handovers from the *oAR*, and enable *MN* choosing a *nAR* with the best match to the QoS request.

B. Dynamic MAP Selection Mechanism

In the section, we propose a dynamic *MAP* selection mechanism that takes an *MN's* load, Session

Mobility Ratio (*SMR*), Binding update cost and location rate. The dynamic selection mechanism consists of four procedures. One is the Checking Load, Second is *SMR*, third is Binding update cost and fourth is Location rate. Detailed descriptions for each procedure will be elaborated in the following section.

1. *Checking Load:* Initially, in the Multiple *MAP* environments, a *MN* collects all *RA* messages sent from the available *MAPs* in the foreign network. The *MN* can obtain information for each MAP using the *RA* messages. We will get the network load and hop distance. The network load will change according to time so to take the dynamic load we will consider the predefined time interval. From these *RA* messages we will get the Network load so we will check the load on each *MAP*. Since the time latency for each *MAP* to the *MN* is not same, *RA* messages arrive at the *MN* at different times. Therefore, the *MN* collects *RA* messages during a predefined time interval (T).
2. *Calculation of SMR:* The *MN* estimates its Session Mobility Ration (*SMR*) by calculating the number of handoffs and session arrivals for each Measurement Interval (*MI*). According to the time interval the *MN* updates it *SMR* by comparing the estimated *SMR* with the two *SMR* threshold values.

$$SMR = \frac{Session\ arrivial\ count}{Mobility\ rate} = \frac{N_S}{N_m} \quad (1)$$

In the equation (1) N_s and N_m are the session arrival count and mobility rate. In *SMR* N_s is the amount of ongoing session of the *MN*, which could be calculated by *MN* itself during specific time duration (i.e. the measurement interval). N_m is the mobility rate and that is expressed as the *AR's* coverage is divided by the reside time which the *MN* within in the *AR's* coverage.

For each time interval (i.e. Measurement intervals), the MN estimated its *SMR* by measuring the number of handoffs and session arrivals. At the same time, the *MN* updates its *SMR* and compare with the estimated *SMR* with the two *SMR* threshold values (*th1* and *th2*). In order to select optimal *MAP* adaptively, we will define two *SMR* threshold values: Minimum *SMR* value and Maximum *SMR* value. In the *MAP* selection, if the new *SMR* is smaller than the lower *SMR* threshold value, then we select that *MAP* because the mobility is relatively larger than the number of session arrival, it will lead to the higher cost of a binding update in this condition. Otherwise we will wait until one time interval and again we will calculate the *SMR* of that *MAP*. The *MN* selects the *MAP* that minimizes the total cost.

In order to avoid the sudden changes of session activity or mobility rate, in this paper we are using the Exponentially weighted moving average (EWMA) [7] for estimation of the SMR.

$$E_{SMR}(i+1) = \alpha \,.\, E_{SMR}(I) + (1-\alpha) \,.\, C_{SMR} \quad (2)$$

Where E_{SMR} is the estimated SMR and C_{SMR} is the current measured SMR and we will calculate the SMR according to the time interval. For each MI we calculate the SMR and we compare with the threshold values. Here α is a weighting parameter, where $0 < \alpha < 1$.

3. *Calculation of Binding Update Cost (BUC):* Binding update cost [7] is the cost of the update the message about the new care-of address of a mobile node. It is measured as number of *BU* messages to the *MAP* and to the *HA*. Based on the regional care-of-address, an on-line care-of-address (*LCoA*) the *MAP BU* message and the HA BU messages have different effects. We are define an weighted binding update cost as follows:

$$BU = \alpha \cdot NHA + \beta \cdot NMAP \quad (3)$$

In equation 3, α and β are weight values for the HA, MAP binding update. The hop distances between the MN is directly proportional to these weight values and if they are not stated then we assign values like 10, 2.

4. *Calculation of Location Rate (LR):* In an unit time how many different *AR's* are attached to *MN* is called as Location Rate [13]. If the same AR attached multiple times in an unit time we will list only once. The visited *AR's* addresses are recorded in list by the *MN*. The list is manages as follows: At starting all *AR* lists are cleared, and the address of the currently attached *AR* is added into the list as the first entry. When *MN* changes its attached *AR* to new *AR* then it check the list for new *AR* address if it is not in list then it will add to the list. At the end of unit time we will calculate the Location rate

$$Location\ Rate = \frac{Number\ of\ entries}{Unittime} \quad (4)$$

5. *Procedure for Dynamic MAP Selection*: In Dynamic *MAP* Selection first we collect the data about all about available *MAPs*. We will check the load by sending the *RA* messages to all the *MAP's*. Calculate the *SMR* by calculating the eq 1. After getting the values of load, *SMR*, *BUC* and Location rate, we will compare with the threshold values and if the values all are greater than the threshold values then we will select the optimal *MAP* otherwise we will start the process again. The process is described in following Flow Diagram.

Procedure for MAP Selection

Define the values of min and max threshold value

1. For each *MAP Mi*

1.1. Check the load of *Mi*
1.2. Calculate the *SMR* of *Mi*
1.3. Calculate the *BUC* of *Mi*
1.4. Calculate the *LR* of *Mi*

1.4.1. If (*SMR*(*Mi*) < th1 and load(*Mi*) <th2 and *BUC*(*Mi*)<th3 and LR(*Mi*)<th4)

MN will register with that *Mi*

Else

Wait for one time interval

Endif

2. End For

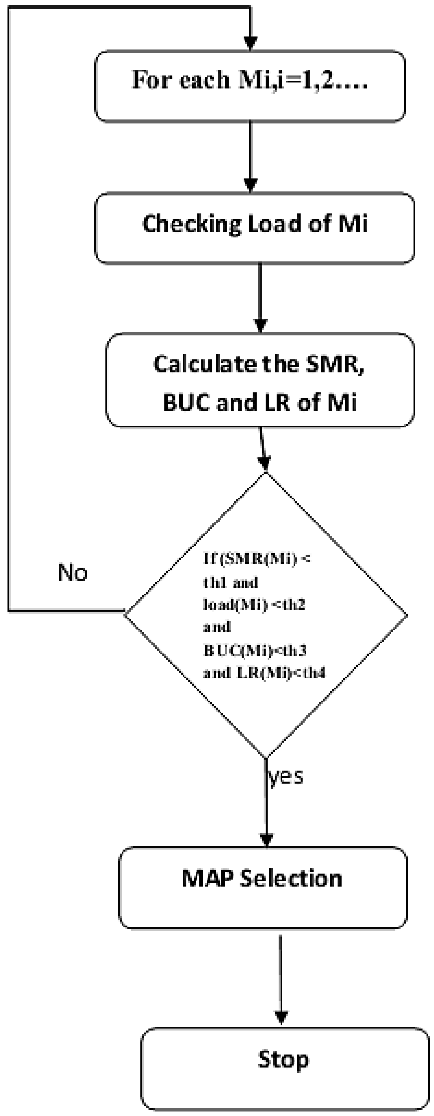

Figure 2: Flow Diagram for Adaptive MAP Selection

C. AR Selection

After selecting the best *MAP*, the Diffserv approach [11] is used to select the *AR* under the *MAP*, based on its resource availability. The *AR* is implemented at the edge router of Diffserv. We are adding two more parameters to the Diffserv to select an optimal *AR* and those two parameters are Signal Strength and Moving direction.

For *AR* selection, we propose a mechanism to control network resources on mobile access routers by extending Differentiated Services (Diffserv) to the *HMIPv6* architecture. DiffServ is a computer networking architecture that specifies a simple, scalable and coarse-grained mechanism for classifying and managing network traffic and providing quality of service (QoS) on modern IP networks. DiffServ can be used to provide low-latency to critical network traffic such as voice or streaming media while providing simple best-effort service to non-critical services such as web traffic or file transfers. By using this mechanism, we can assure that better resource utilization and throughput can be attained during Handoff in *HMIPv6* networks.

Based on DiffServ Mechanism, AR will classify and mark packets. We are adding two new *ICMPv6* options used by *AR* to advertise information to *MN*; and then *MN* will use this information as criteria for choosing the new access router in the handover procedure.

1. *AR's Router Advertisement Message:* The Router Advertisement message is sent out periodically with the type 3 option and that options are used to specify the prefixes that are used for address auto configuration. Using the available resources the MN has to choose best *nAR*. For neighbor discovery message of *IPv6* we are implementing two new additional *ICMPv6* options. These two options are type 9 and type 10 options, which are used for advertising the remaining resources and Diffserv QoS configuration parameters on certain Access Routers.

It must attach type 9 and 10 options to the message, when the Access Router sends out Router Advertisement with type 3 options. *MN* uses information about type 9 option to select the best Access Router for handover. Type 9 option includes current available bandwidth and dropping percentage information of each class of service on Access Router and Signal Strength. Type 10 option informs *MN* the pre-defined Diffserv service class in which the information for each class consisting of class bandwidth and list of applications within each class and Moving direction. We categorize the application by using protocol and port number. The information in type 10 option is used when mobile determine to move into a new Diffserv domain. The option formats of type 9 and 10 options are as depicted in Table 1.

2. *Handover Procedure:* Handover on HMIPv6 can be classified into two types. One is intra-MAP handover and the second one is inter-MAP handover. Figure 4 describes the steps of Intra-MAP handover procedure.

Table 1: Router Advisement Message with Type 9, 10 Options

TYPE	Type 9	Available Bandwidth Width (Kbps)	%Dropped packets	DiffServ Domain Number	Signal Strength
	Type 10	DiffServ Domain Class	DiffServ Domain Protocol	DiffServ Domain Port	Moving directin
		Next port	Next class	……	

In Intra-MAP handover procedure at step 1, 2 and 3, *MN* sends application data to CN via *oAR* and *MAP*. Each *AR* forward packets to the next hop and in that packet header a Differentiated Service Code Point *(DSCP)* value is pinned. At step 4, *MN* moves into an overlapping area of *oAR*, *nAR1*. The *MN* will receive *RtAvt* (type 8 and 9) from both *nARs*. In this situation *MN* chooses *nAR1*, because it best matches resources available for *MN*. At step 5 and 6, *MN* makes Local Binding Update *(LBU)* process with *MAP*. After that at step 8, 9 and 10, *MN* continues sending application data to *CN* via *nAR1*.

Steps of Inter-MAP handover procedure are shown in Figure 5. This procedure is parallel to the Intra-Map handover, but it is different at step 6, 7, 8 and 9. In case of Inter-MAP handover, *MN* has to update its *LCOA* and *RCOA*. The *oMAP* will get the data from *nMAP* and *nMAP* is selected using dynamic *MAP* selection. After that, MN will inform *nMAP* the local binding update message that contains new *LCOA* and *RCOA* and then perform Binding update with new *RCOA* to *HA* and *CN*.

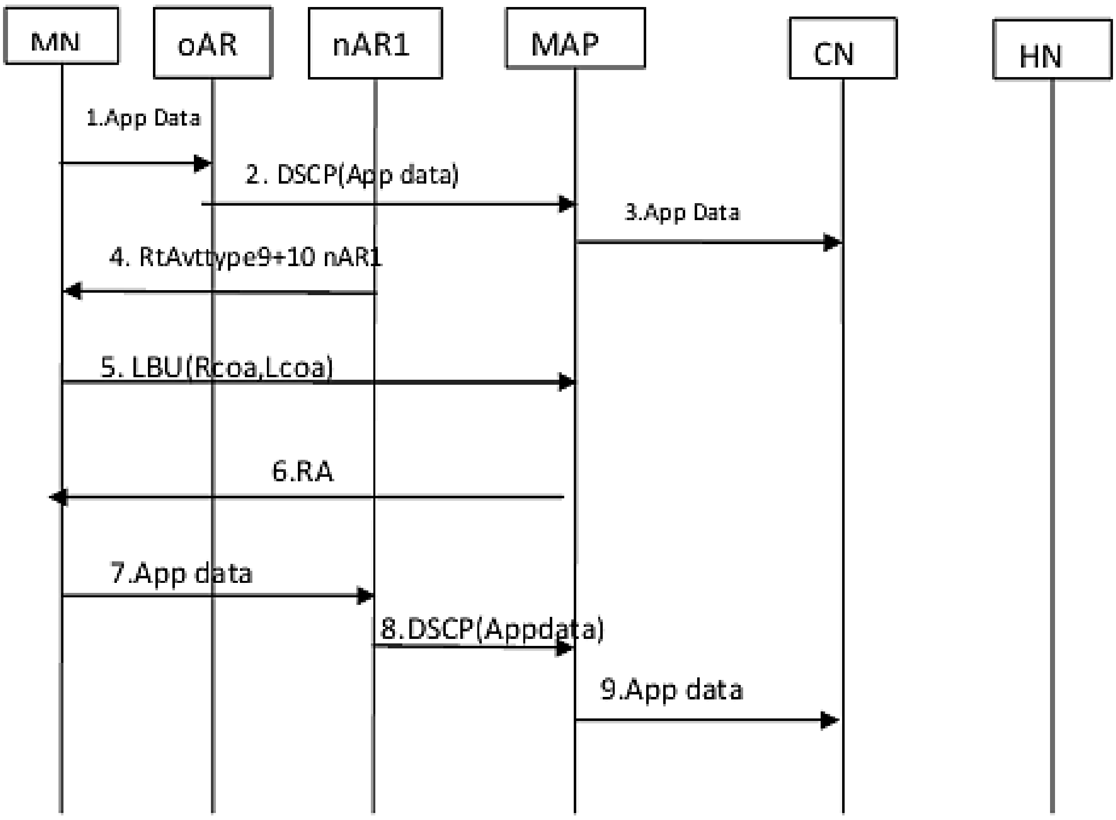

Figure 3: Intra-MAP Handover Procedure

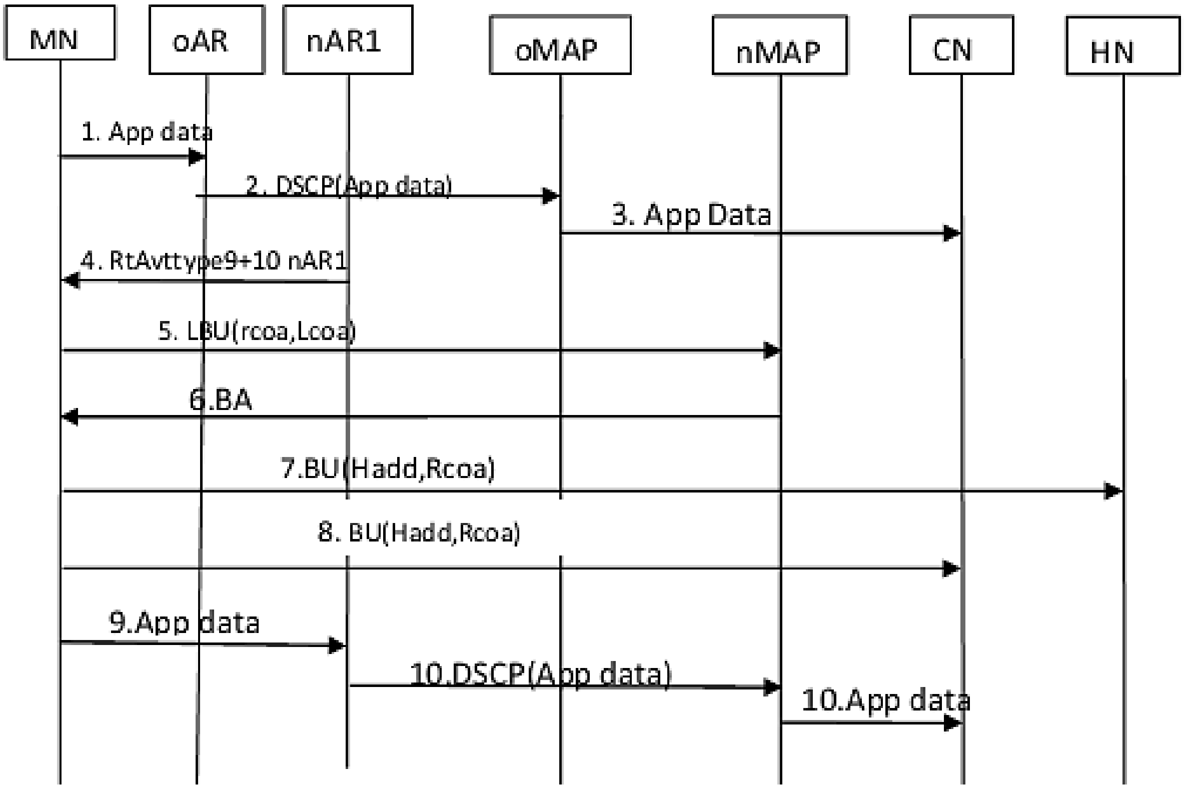

Figure 4: Inter-MAP Handover Procedure

In handover procedure there is no *nARn* so the process was changed

3. *Example of Handover Procedure:* In the example consider the one *MAP* with three *AR's* and on *CN*. The following procedure describes how MN will communicate with *MAP*, *AR's* and *CN*.

   i. *Intra-MAP Handover Procedure:* In Intra-MAP handover procedure at step 1, 2 and 3, *MN* sends application data to *CN* via *oAR* and *MAP*. Figure 5 is explained step-by-step procedure.

   – *MN* will send the *RA* messages to *oAR* to get the details of which domain it is and under the which *MAP*
   – The *oAR* send the Diff Server pin code value to *MAP*
   – The *MAP* will send the data to *CN*
   – The new *AR* will send the type 9 and type 10 values to *MN*
   – The *MN* will do Local Binding with *MAP*
   – *MAP* will send the *RA* messages to *MN* to choose the *AR*
   – The *MN* will choose the New *AR* and send the data
   – *nAR1* send the data to *MAP*
   – *MAP* will send data to *CN* which *AR* has selected

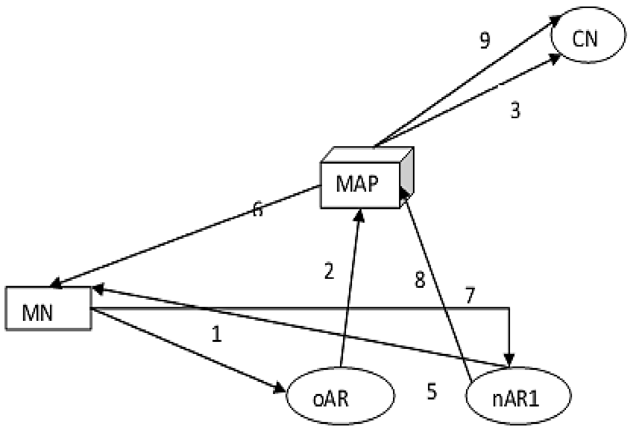

Figure 5: Intra-MAP Handover Procedure

   ii. *Inter-MAP Handover Procedure:* Steps of Inter-MAP handover procedure are shown in Figure 6. This procedure is parallel to the Intra-Map handover, but it is different at step 6, 7, 8 and 9.

   – *MN* will send the *RA* messages to *oAR* to get the details of which domain it is and under the which *MAP*
   – The *oAR* send the Diff Server pin code value to *oMAP*
   – The *oAP* will send the data to *CN*
   – The new *AR1* will send the type 9 and type 10 values to *MN*

- The *MN* will do Local Binding with *nMAP* and the new *MAP* will select by using the dynamic MAP selection
- *nMAP* will send the *RA* messages to *MN* to choose the AR
- The *MN* sends the local binding update message that contains new *LCOA* and *RCOA* and then performs Binding updates with new *RCOA* to *HA*.
- The *MN* sends the local binding update message that contains new *LCOA* and *RCOA* and then performs Binding updates with new *RCOA* to *CN*.
- The *MN* will choose the New *AR* and send the data
- *nAR1* send the data to *nMAP*
- *nMAP* will send data to *CN* which *AR* has selected

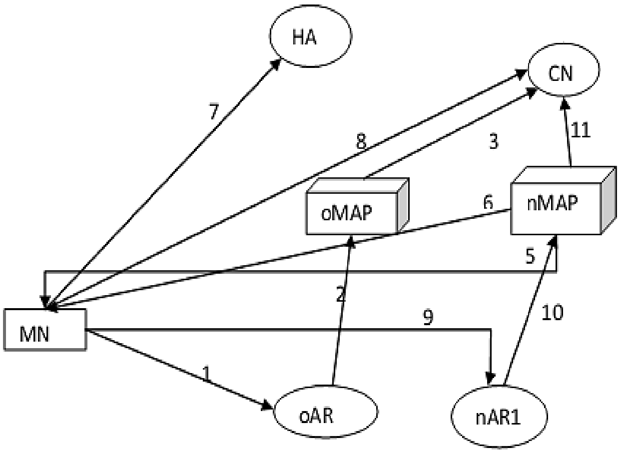

Figure 6: Inter-MAP Handover Procedure

IV. SIMULATION RESULTS

A. Simulation Setup

We use NS2 [12] to simulate our proposed Dynamic MAP and Diffserv based *AR (DMDA)* method with P_HMIPv6 architecture. In our simulation, the channel capacity of mobile hosts is set to the same value: 2 Mbps. We use the distributed coordination function *(DCF)* of IEEE 802.11 for wireless *LANs* as the MAC layer protocol. It has the functionality to notify the network layer about link breakage. The following table *(Table.1)* summarizes the simulation settings. The *CBR* traffic is established from *CN* to *MS*, and the bandwidth and latency for every link between every two components are also specified in this scenario. The topology in figure4 is used in our simulation. We have simulated both horizontal (layer3) and vertical handoff in our system.

Figure 7 shows the screenshot of Network Animator *(NAM)* output of simulation topology.

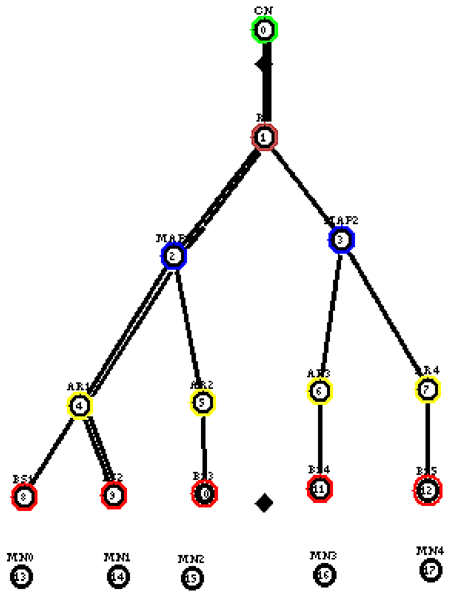

Figure 7: Simulation Topology

Table 2: Simulation Settings

No. of Mobile Nodes	5
No. of APs	5
Area Size	600 X 600
Mac	802.11
Simulation Time	50 sec
Traffic Source	CBR
Packet Size	512
Speed	25 m/s
Transmission range	250m
Routing Protocol	AODV

B. Performance Metrics

We compare our proposed *DMDA* with *P_HMIPv6* scheme. We mainly evaluate the performance according to the following metrics:

Packet Delivery Ratio: It is the ratio of number of packets received successfully into total number of packets sent.

Throughput: It is the average number of packets received

Packet Drop: It is the average number of packets dropped in the mobile hosts.

Delay: It is average the end-to-end delay

The performance results are presented in the next section.

C. Results

Case 1: Complete Transmission

1. *Varying Rate:* In our first experiment we vary the rate as 50,100,150,200 and 250kb.

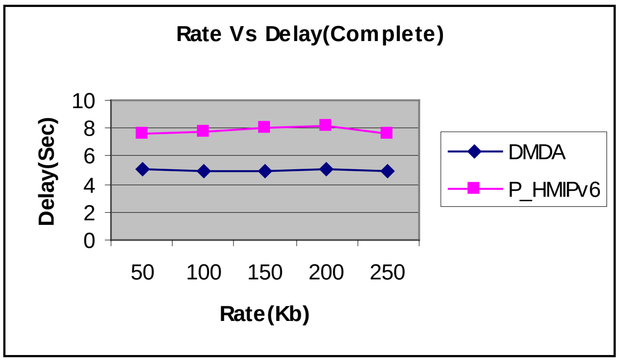

Figure 7: Rate vs. Delay

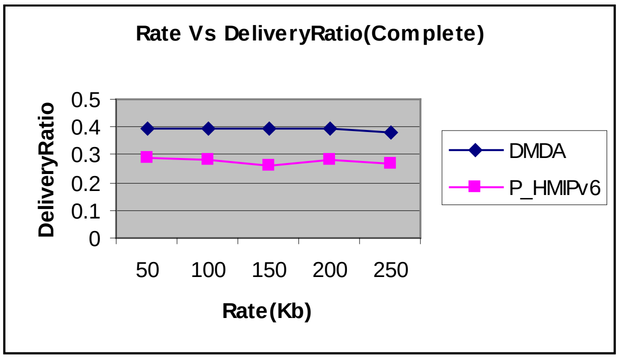

Figure 8: Rate vs. Delivery Ratio

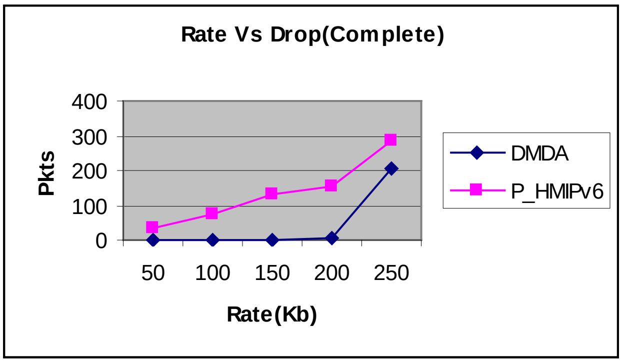

Figure 9: Rate vs. Drop

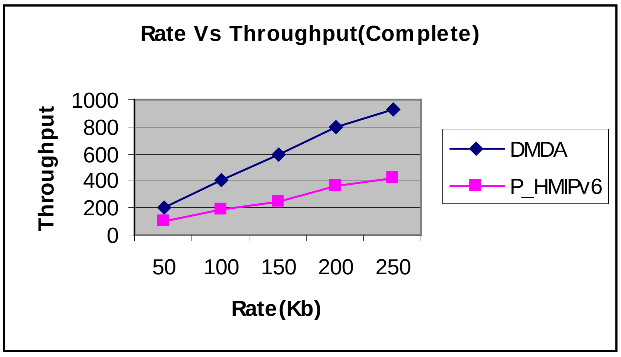

Figure 10: Rate vs. Throughput

From figure 7, we can see that the delay of our proposed *DMDA* is less than the existing *P_HMIPv6* method.

From figure 8, we can see that the delivery ratio of our proposed *DMDA* is higher than the existing *P_HMIPv6* method.

From figure 9, we can see that the packet drop of the proposed *DMDA* is less than the existing *P_HMIPv6* method.

From figure 10, we can see that the throughput of our proposed *DMDA* is higher than the existing *P_HMIPV6* method.

2. *Based on Time:* In our second experiment we vary the time as 0,2,4,6,8,10 and 12 sec

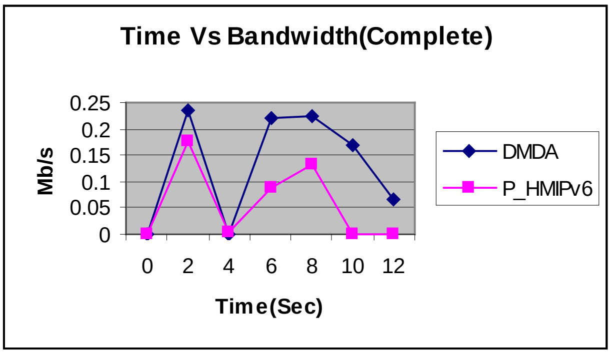

Figure 11: Time vs. Bandwidth

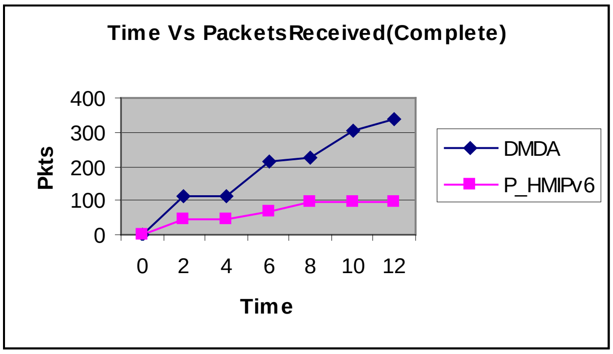

Figure 12: Time vs. Packets Received

From figure 11, we can see that the received bandwidth of our proposed *DMDA* is higher than the existing *P_HMIPv6* method.

From figure 12, we can see that the packets received ratio of our proposed *DMDA* is higher than the existing *P_HMIPV6* method

Case-2: Inter Transmission

1. *Based on Rate:* In this experiment we vary the rate as 50,100,150,200 and 250kb.

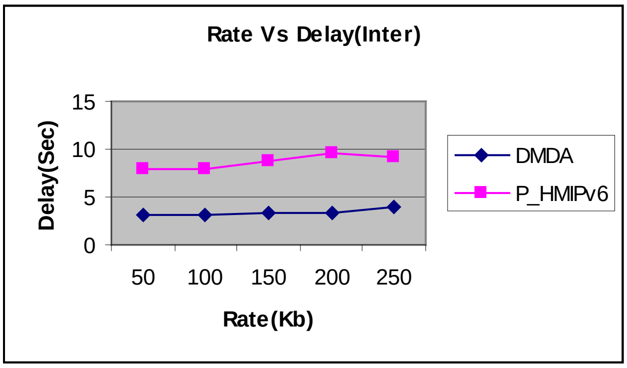

Figure 13: Rate vs. Delay

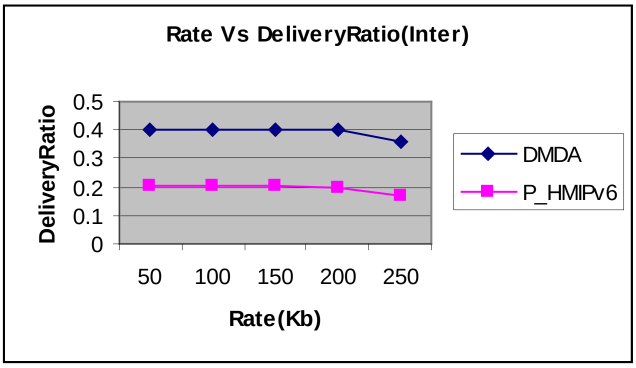

Figure 14: Rate vs. Delivery Ratio

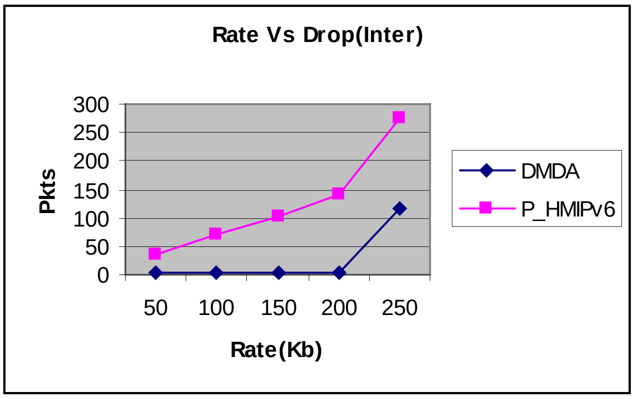

Figure 15: Rate vs. Drop

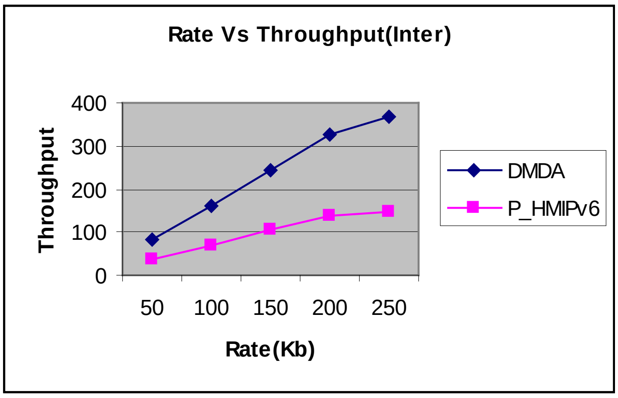

Figure 16: Rate vs. Throughput

From figure 13, we can see that the delay of our proposed *DMDA* is less than the existing *P_HMIPv6* method.

From figure 14, we can see that the delivery ratio of our proposed *DMDA* is higher than the existing *P_HMIPv6* method.

From figure 15, we can see that the packet drop of our proposed *DMDA* is less than the existing *P_HMIPv6* method.

From figure 16, we can see that the throughput of our proposed *DMDA* is higher than the existing *P_HMIPV6* method

Case-3: Intra Transmission

1. *Based on Rate:* In this experiment we vary the rate as 50,100,150,200 and 250kb.

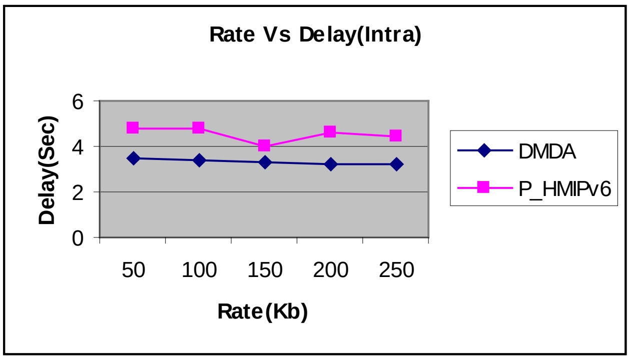

Figure 17: Rate vs. Delay

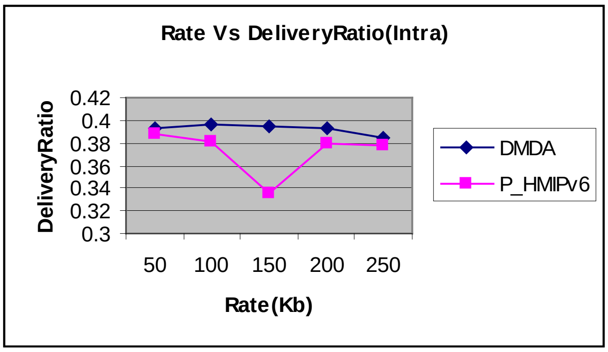

Figure 18: Rate vs. Delivery Ratio

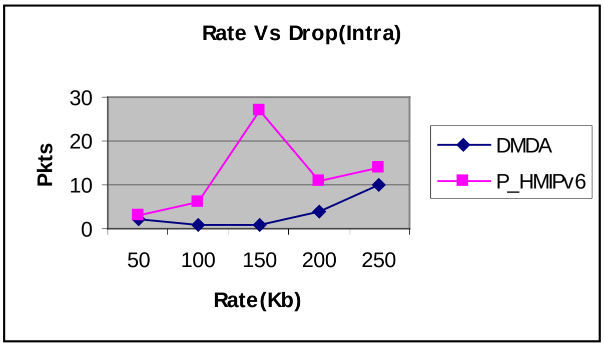

Figure 19: Rate vs. Drop

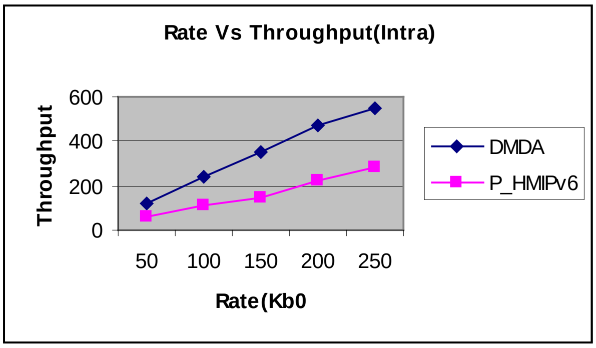

Figure 20: Rate vs. Throughput

From figure 17, we can see that the delay of our proposed *DMDA* is less than the existing *P_HMIPv6* method.

From figure 18, we can see that the delivery ratio of our proposed *DMDA* is higher than the existing *P_HMIPv6* method.

From figure 19, we can see that the packet drop of our proposed *DMDA* is less than the existing *P_HMIPv6* method.

From figure 20, we can see that the throughput of our proposed *DMDA* is higher than the existing *P_HMIPV6* method

V. CONCLUSION

In this paper, we have proposed a Dynamic *MAP* and *Diffserv* based ARs selection for Handoff in HMIPv6 networks. The dynamic *MAP* will be selected based on the values of load, Session Mobility Ratio, Binding update cost and Location rate. By considering the *SMR* in the selection of *MAP*, the *MN* is able to select a more appropriate *MAP* with respect to its own mobility and session activity. After selecting the best *MAP*, we are using the Differentiated Services *(Diffserv)* approach to select the *AR* under the *MAP*, based on its resource availability. The *AR* is implemented at the edge router of Diffserv. The advantage of using the Diffserv is to enable MN to be able to choose the best AR before performing the handover and quality of service of each application type on MN. As a future work, we wish to analyze the effects of losses and provide undisturbed transmission of real time traffic by suitable transport layer mechanisms.

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